Docket No. CALT-2806 (032634-000014) Cofc

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	Burrows		
SERIAL NO.:	09/419,347	CONFIRMATION NO.:	1097
FILING DATE:	Oct 15, 1999		
TITLE:	Ion Exchange Waveguides and Methods of Fabrication		
PATENT NO.:	6,786,967		
ISSUED:	Sep 7, 2004		
EXAMINER:	Felisa C. Hiteshew		
ART UNIT:	1765		

Certificate
JUN 24 2005
of Correction

CERTIFICATE OF MAILING

I hereby certify that this paper is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450 Alexandria, VA 22313-1450, on the date printed below:

Date: June 16, 2005 Name: P Sherman
Penelope Sherman

Commissioner for Patents,
P.O. Box 1450 Alexandria, VA 22313-1450

TRANSMITTAL FOR CERTIFICATE OF CORRECTION

We enclose, pursuant to the provisions of 37 C.F.R. §1.322, a Certificate of Correction for United States Patent No. 6,786,967. Please make the Certificate of Correction and the statements herein of record.

The corrections made to the above-identified United States Patent in the Certificate of Correction filed herewith are to correct mistakes which are of a minor character according to 35 U.S.C. §254 and 37 C.F.R. §1.322. The proposed corrections do not

constitute such changes in the patent as would constitute new matter or would require re-examination.

37 C.F.R. §1.322 Corrections

Please see attached Certificate of Correction.

No Fee Due

It is believed that no fee is required for filing the above-noted document. In the event any fee is required for filing of this Certificate of Correction, the Assistant Commissioner is hereby authorized to charge the fee to our Deposit Account No. 50-1698.

Respectfully submitted,
THELEN REID & PRIEST LLP

Dated: June 15, 2005

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PTO/SB/44 (04-04)
Approved for use through 04/30/2007. OMB 0651-0033
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO : 6,786,967

DATED : Sep 7, 2004

INVENTOR(S) : Burrows et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

1) In Section 56 of the cover page, References Cited insert an --*-- by US Patent 4,725,330.

2) In column 1 line 55 replace "OLiNbO.sub.3" with --LiNbO.sub.3--.

3) In Column 2 line 31 replace "RMO3," with --RMO.sub.3,--.

4) In Column 5 line 63 replace "RE" with --RIE--.

5) In Column 8 line 53 replace "tube s" with --tube--.

MAILING ADDRESS OF SENDER: Thelen Reid & Priest
PO Box 640640
San Jose, CA 95164-0640

PATENT NO. 6,786,967

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Notice of References Cited

Application/Control No.	Applicant(s)/Patent Under Reexamination	
10/419,347	DREXL ET AL.	
Examiner	Art Unit	Page 1 of 1
Felisa C. Hiteshew	1765	

Correction 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US- 4,725,330	02-1988	Holmes, et al	117/200
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

This Will Acknowledge receipt of the following application papers at the U.S. Patent Office:

Inventors: Lee J. Burrows

This Will Acknowledge receipt of the following application papers at the U.S. Patent Office:

Inventors: Lee J. Burrows

RECEIVED

Filing Date: October 15, 1999

OCT 27 1999

Invention for: ION EXCHANGE WAVEGUIDES AND METHODS OF FABRICATION

D'ALESSANDRO & RITCHIE

Having: Utility Patent Application Transmittal, 24 pages of specification, 13 pages of claims, one page of Abstract, and 7 sheets of Drawings

Docket No. CALT-2973

Attorney: **David B. Ritchie**

Express Mail No.: EL100016887US

PLEASE HOLD FOR SERIAL NUMBER

This Will Acknowledge receipt of the following application papers at the U.S. Patent Office:

Inventors: Lee J. Burrows

Filing Date: October 15, 1999

Invention for: ION EXCHANGE WAVEGUIDES AND METHODS OF FABRICATION

Having: Utility Patent Application Transmittal, 24 pages of specification, 13 pages of claims, one page of Abstract, and 7 sheets of Drawings

Docket No. CALT-2973

Attorney: **David B. Ritchie**

Express Mail No.: EL100016887US

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D'ALESSANDRO & RITCHIE

JUN 27 2005

STATEMENT AS TO RIGHTS TO INVENTIONS

The United States Government has certain rights in this invention pursuant to Grant No. F-19628-95-C-0002 awarded by the United States Air Force.

BACKGROUND OF THE INVENTION

Field Of The Invention

The present invention relates to a method for fabricating ion exchange waveguides in optical modulators using pressurized annealing and the resulting waveguides and modulators. More particularly, the present invention relates to a method for fabricating lithium niobate-ion or lithium tantalate-ion exchange waveguides using a pressurized oxygen atmosphere anneal process to further diffuse ions in the exchange region.

Background

Optoelectronic components can be fabricated on several types of substrates including polymers, glass, semiconductors (e.g., gallium arsenide (GaAs) and indium phosphide (InP)) and inorganic materials (e.g., lithium niobate ($LiNbO_3$) and lithium tantalate ($LiTaO_3$)). Characteristically, an electro-optic material is one in which the index of refraction changes with the application of an electric field. One of the most important components in optoelectronic systems is the modulator. Three competing technologies in this realm are: direct modulation of a semiconductor laser, semiconductor electro-absorption modulators, and the lithium niobate modulator. Currently, lithium niobate modulators are the modulation devices of choice for many systems because they yield

Correction 2

high performance, are a relatively mature technology and other modulation schemes impose limits not faced with lithium niobate modulators.

Lithium niobate has proven to be a suitable medium for components such as amplitude modulators, phase modulators, optical switches, polarization transformers, tunable filters and wavelength-selective optical add/drop filters. Lithium niobate has also been used as the host for solid state lasers using rare earth ions, e.g., erbium. Most current telecommunication and cable television system applications for $LiNbO_3$ modulators involve discrete components for the optical transmitter subsystem. This configuration couples continuous wave lasers, typically diode-pumped YAG or erbium fiber oscillators, with lithium niobate external modulators and various wavelength and power stabilization components.

Lithium niobate is a popular nonlinear optical crystal for several reasons including its large electro-optic coefficients, the ease with which high quality optical waveguides are fabricated and its amenability to conventional integrated circuit processing techniques. High quality optical waveguides are those that possess low loss and relatively high power handling capabilities. Additionally, $LiNbO_3$ is a hard material, thus it is easily polished for fiber optical coupling which makes its use in optical network systems relatively uncomplicated. It is also a relatively inexpensive crystal, due in part to its long history of use in surface-acoustic-wave (SAW) filters for radio frequencies. By comparison, lithium tantalate $LiTaO_3$ is essentially interchangeable with lithium niobate as far as modulator characteristics are concerned, but the use of $LiTaO_3$ is often cost prohibitive because it is not as widely commercially used as $LiNbO_3$. Additionally, other optical crystalline structures having the formula RMO_3, where R is an alkaline earth

R Correction 3

selectively etches away the material chosen as mask layer 14. It should be noted that the etch process should preferably avoid wet etching. Wet etching generally involves the use of acids and thus would generally be likely (unless deuterated acids are used) to introduce free protons into the waveguide scheme that would adversely affect the $LiNbO_3$. As previously discussed, free protons in the waveguide tend to increase the likelihood of output voltage drift over time.

Correction 4

Once the plasma etch or RIE process is completed it may be desirable to strip away residual photoresist. However, in some instances the photoresist will be robust enough to withstand exposure to acidic materials and thus no stripping process needs to be employed. If an optional stripping process is used it may be accomplished with an oxygen plasma or by using an acetone wash. The use of acids for stripping purposes should be avoided as they have a tendency to introduce free protons into the modulator construct and these free protons increase the likelihood of latent drift in the modulators.

Referring to FIG. 1D, shown is the modulator build 10 after undergoing initial ion exchange diffusion. The exposed $LiNbO_3$ crystal substrate 12 is treated with an acid, preferably a deuterated acid, such as deuterated sulfuric acid (D_2SO_4), deuterated benzoic acid ($C_7D_6O_2$) or another suitable deuterated acid. Deuterated sulfuric acid may be obtained in pure concentration from the Alfa Aesar Corporation of Ward Hill, Massachusetts and other vendors.

The use of deuterated acids in the diffusion process is beneficial for providing stability and immobility to the crystal lattice structure. The deuterium atom has an additional neutron in the presence of a hydrogen atom, and has a mass approximately

Once the container of FIG. 2A is properly assembled it can be placed within a sealable and pressurizable vessel 120. A cross-sectional view of such a vessel is shown in FIG. 2B, enclosing the container 100 of FIG. 2A. The pressurizable vessel 120 is typically formed from a metal material such as stainless steel or a quartz or ceramic tube with pressure fittings on it. In this illustration vessel 120 is tube-like in structure and has fittings 122 and 124 at opposite ends of vessel 120. Fitting 122 is a fixed fitting and fitting 124 allows for vessel 120 to be vacuum pumped and pressurized with oxygen gas.

Correction 5

Additionally, annealing with lithium niobate powder can be undertaken without the use of the container, such as the one shown in FIG. 2A. It is also possible and within the inventive concept herein disclosed to place the lithium niobate powder directly in pressurized vessel 120. However, the quantity of required lithium niobate powder increases substantially when the powder is placed directly inside the pressurized vessel, making this alternate embodiment, in most instances, more costly.

The anneal process begins by placing modulator build 100 in a conventional annealing oven. Any suitable oven can be used as the annealing chamber and the use of such ovens are widely known by those of ordinary skill in the art. It is possible to use an anneal oven that has pressurizing capabilities in which case the use of the separate pressurizable vessel of FIG. 2B would be unnecessary. Upon placing the lithium niobate structure into the oven, the oven or pressurizable vessel is sealed and then the oven or pressurizable vessel is vacuum pumped down to approximately 100 microns pressure or less to eliminate contaminants from the annealing environment. The vacuum pump down procedure is optional and in some instances the need to remove